

## Appendix B

### APPLICABLE TABLES AND LANGUAGE FROM STANDARDS AND RACM

#### Standards Tables 116-A and 116-B

TABLE 116-A DEFAULT FENESTRATION PRODUCT U-FACTORS

FRAME <sup>1,2</sup>	PRODUCT TYPE	SINGLE-PANE U-FACTOR	DOUBLE-PANE U-FACTOR	GLASS BLOCK <sup>2</sup> U-FACTOR
Metal	Operable	1.28	0.79	0.87
	Fixed	1.19	0.71	0.72
	Greenhouse/garden window	2.26	1.40	N.a
	Doors	1.25	0.77	N.a
	Skylight	1.98	1.30	N.a
Metal, Thermal Break	Operable	N.a	0.66	N.a
	Fixed	N.a	0.55	N.a
	Greenhouse/garden window	N.a	1.12	N.a
	Doors	N.a	0.59	N.a
	Skylight	N.a	1.11	N.a
Nonmetal	Operable	0.99	0.58	0.60
	Fixed	1.04	0.55	0.57
	Doors	0.99	0.53	N.a
	Greenhouse/garden windows	1.94	1.06	N.a
	Skylight	1.47	0.84	N.a
<p>1. For all dual-glazed fenestration products, adjust the listed U-factors as follows:</p> <ul style="list-style-type: none"> <li>a. Add 0.05 to products with dividers between panes if spacer is less than 7/16 inch wide.</li> <li>b. Add 0.05 to any product with true divided lite (dividers through the panes).</li> </ul> <p>2. Translucent or transparent panels shall use glass block values.</p>				

**TABLE 116-B DEFAULT SOLAR HEAT GAIN COEFFICIENT (SHGC)**

FRAME TYPE	PRODUCT	GLAZING	TOTAL WINDOW SHGC		
			Single Pane	Double Pane	Glass Block <sup>1</sup>
Metal	Operable	Clear	0.80	0.70	0.70
	Fixed	Clear	0.83	0.73	0.73
	Operable	Tinted	0.67	0.59	N.a
	Fixed	Tinted	0.68	0.60	N.a
Metal, Thermal Break	Operable	Clear	N.a	0.63	N.a
	Fixed	Clear	N.a	0.69	N.a
	Operable	Tinted	N.a.	0.53	N.a
	Fixed	Tinted	N.a.	0.57	N.a
Nonmetal	Operable	Clear	0.74	0.65	0.70
	Fixed	Clear	0.76	0.67	0.67
	Operable	Tinted	0.60	0.53	N.a
	Fixed	Tinted	0.63	0.55	N.a

1. Translucent or transparent panels shall use glass block values.

**§118 (d) and §118 (e)**

(d) **Installation of Insulation in Existing Buildings.** Insulation installed in an existing attic, or on an existing duct or water heater, shall comply with the applicable requirements of subsections 1, 2, and 3 below. If a contractor installs the insulation, the contractor shall certify to the customer, in writing, that the insulation meets the applicable requirements of subsections 1, 2, and 3 below.

1. **Attics.** If insulation is installed in the existing attic of a low-rise residential building, the R-value of the total amount of insulation (after addition of insulation to the amount, if any, already in the attic) shall be at least R-38 in climate zones 1 and 16; and R-30 in all other climate zones.

**EXCEPTION to §118 (d) 1:** Where the accessible space in the attic is not large enough to accommodate the required R-value, the entire accessible space shall be filled with insulation provided such installation does not violate Section 1203.2 of Title 24, Part 2.

2. **Water heaters.** If external insulation is installed on an existing unfired water storage tank or on an existing back-up tank for a solar water-heating system, it shall have an R-value of at least R-12, or the heat loss of the tank surface based on an 80°F water-air temperature difference shall be less than 6.5 Btu per hour per square foot.
3. **Ducts.** If insulation is installed on an existing space-conditioning duct, it shall comply with Section 605 of the CMC.

(e) **Placement of roof/ceiling insulation.** Insulation installed to limit heat loss and gain through the top of conditioned spaces shall comply with the following:

1. Insulation shall be installed in direct contact with a continuous roof or ceiling which is sealed to limit infiltration and exfiltration as specified in §117, including but not limited to placing insulation either above or below the roof deck or on top of a drywall ceiling; and
2. When insulation is installed at the roof in nonresidential buildings, fixed vents or openings to the outdoors or to unconditioned spaces shall not be installed and the space between the ceiling and the roof is either directly or indirectly conditioned space and shall not be considered an attic for the purposes of complying with CBC attic ventilation requirements; and
3. Insulation placed on top of a suspended ceiling with removable ceiling panels shall be deemed to have no affect on envelope heat loss; and

**EXCEPTION to §118(e) 3:** When there are conditioned spaces with a combined floor area no greater than 2,000 ft<sup>2</sup> in an otherwise unconditioned building, and when the average height of the space between the ceiling and the roof over these spaces is greater than 12 ft, insulation placed in direct contact with a suspended ceiling with removable ceiling panels shall be an acceptable method of reducing heat loss from a conditioned space and shall be accounted for in heat loss calculations.

4. Insulation shall be installed below the roofing membrane or layer used to seal the roof from water penetration unless the insulation has a maximum water absorption of 0.3 percent by volume when tested according to ASTM Standard C 272.

**NOTE:** Vents, which do not penetrate the roof deck that are designed for wind resistance for roof membranes are not within the scope of §118(e)2.

---

### **§150 (a) and §150 (b)**

Any new construction in a low-rise residential building shall meet the requirements of this Section.

- (a) **Ceiling Insulation.** The opaque portions of ceilings separating conditioned spaces from unconditioned spaces or ambient air shall meet the requirements of either Item 1 or 2 below:
  1. Ceilings shall be insulated between wood-framing members with insulation resulting in an installed thermal resistance of R-19 or greater for the insulation alone.

**ALTERNATIVE to §150 (a) 1:** Insulation which is not penetrated by framing members may meet an R-value equivalent to installing R-19 insulation between wood-framing members and accounting for the thermal effects of framing members.
  2. The weighted average U-factor of ceilings shall not exceed the U-factor that would result from installing R-19 insulation between wood-framing members in the entire ceiling and accounting for the effects of framing members.
- (b) **Loose-fill Insulation.** When loose-fill insulation is installed, the minimum installed weight per square foot shall conform with the insulation manufacturer's installed design weight per square foot at the manufacturer's labeled R-value.

**Standards Tables 151-B, 151-C and 151-D**

**STANDARDS TABLE 151-B COMPONENT PACKAGE C**

Climate Zone	1, 16	3	4	5	6	7	8, 9	10	2, 11-13	14	15
<b>BUILDING ENVELOPE</b>											
Insulation minimums <sup>1</sup>											
Ceiling	R49	R38	R38	R38	R38	R38	R38	R49	R49	R49	R49
Wood-frame walls	R29	R25	R25	R25	R21	R21	R21	R25	R29	R29	R29
“Heavy mass” walls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
“Light mass” walls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Below-grade walls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Slab floor perimeter	R7	R7	R7	R7	R7	R7	R7	R7	R7	R7	R7
Raised floors	R30	R30	R30	R30	R21	R21	R21	R30	R30	R30	R21
Concrete raised floors	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radiant Barrier	NR	NR	REQ	NR	NR	NR	REQ	REQ	REQ	REQ	REQ
Roofing Products	See Standards TABLE 151-C, COMPONENT PACKAGE D										
<b>FENESTRATION</b>											
Maximum U-factor <sup>2</sup>	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
Maximum Solar Heat Gain Coefficient (SHGC) <sup>3</sup>	NR	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Maximum total area	14%	14%	14%	16%	14%	14%	14%	16%	16%	14%	16%
Maximum West facing area	NR	NR	5%	NR	NR	5%	5%	5%	5%	5%	5%
THERMAL MASS <sup>4</sup>	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
<b>SPACE-HEATING<sup>5</sup></b>											
Electric-resistant allowed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
If gas, AFUE =	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
If heat pump, HSPF <sup>6</sup> =	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
<b>SPACE-COOLING</b>											
SEER =	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
If split system, Refrigerant charge measurement or charge indicator display	NR	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ
Central Forced Air Handler:	See TABLE 151-C, COMPONENT PACKAGE D										
<b>DUCTS</b>											
Duct sealing	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
Duct Insulation	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8
WATER-HEATING	System shall meet §151 (f) 8 or §151 (b)1 <sup>7</sup>										

STANDARDS TABLE 151-C COMPONENT PACKAGE D

Climate Zone		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
Insulation minimums <sup>1</sup>	Ceilings	R38	R30	R38	R38	R38	R38	R38	R38										
	Walls	Wood-frame walls	R21	R13	R19	R19	R19	R21	R21	R21									
		Heavy mass walls	R4.76	R2.44	R4.76	R4.76	R4.76	R4.76	R4.76	R4.76									
		Light mass walls	NA																
		Below-grade walls	R0	R13															
	Floors	Slab floor perimeter	NR	R7															
		Raised floors	R19	R19															
Concrete raised floors		R8	R8	R0	R8	R4	R8	R8	R4	R8									
Radiant Barrier		NR	REQ	NR	REQ	NR	NR	NR	REQ	NR									
Roofing Products	Low-sloped	Aged Solar Reflectance	NR	0.55	NR	0.55	NR												
		Thermal Emittance	NR	0.75	NR	0.75	NR												
	Steep Sloped (less than 5 lb/ft <sup>2</sup> )	Aged Solar Reflectance	NR	0.20	0.20	0.20	0.20	0.20	0.20	NR									
		Thermal Emittance	NR	0.75	0.75	0.75	0.75	0.75	0.75	NR									
	Steep Sloped (5 lb/ft <sup>2</sup> or more)	Aged Solar Reflectance	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Thermal Emittance	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Fenestration	Maximum U-factor <sup>2</sup>		0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	
	Maximum Solar Heat Gain Coefficient (SHGC) <sup>3</sup>		NR	0.40	NR	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.35	NR	
	Maximum Total Area		20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	
	Maximum West Facing Area		NR	5%	NR	5%	NR	NR	5%	5%	5%	5%	5%	5%	5%	5%	5%	NR	
THERMAL MASS <sup>4</sup>		NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
SPACE-HEATING <sup>5, 10</sup>	Electric-resistant allowed		No																
	If gas, AFUE =		MIN																
	If heat pump, HSPF <sup>6</sup> =		MIN																
SPACE-COOLING	SEER =		MIN																
	If split system, Refrigerant charge measurement or charge indicator display		NR	REQ	NR	NR	NR	NR	NR	REQ	NR								
Central Forced Air Handlers	Cooling Airflow and Watt Draw		NR	REQ	REQ	REQ	REQ	REQ	REQ	NR									
	Central Fan Integrated Ventilation System Watt Draw		REQ																
DUCTS	Duct sealing		REQ																
	Duct Insulation		R-6	R-6	R-6	R-6	R-6	R-4.2	R-4.2	R-4.2	R-6	R-6	R-6	R-6	R-6	R-8	R-8	R-8	
WATER-HEATING		System shall meet §151(f)8 or §151(b)1																	

TABLE 151-D COMPONENT PACKAGE E

			Climate Zone																
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Insulation minimums <sup>1</sup>	Ceilings		R38	R30	R38	R30	R38	R38	R30	R30	R30	R30	R38	R38	R38	R38	R38	R49	
	Walls	Wood-frame walls	R21	R19	R21	R21	R21												
		Heavy mass walls	R4.76	R2.44	R4.76	R4.76	R4.76	R4.76	R4.76	R4.76									
		Light mass walls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Below-grade walls	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R13
	Floors	Slab floor perimeter	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	R7
		Raised floors	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19
Concrete raised floors		R8	R8	R0	R8	R4	R8	R8	R4	R8									
Radiant Barrier			NR	REQ	NR	REQ	NR	NR	NR	REQ	NR								
Roofing Products	Low-sloped	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.55	NR	0.55	NR	
		Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	NR	0.75	NR	
	Steep Sloped (less than 5 lb/ft <sup>2</sup> )	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.20	0.20	0.20	0.20	0.20	0.20	NR	
		Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	0.75	0.75	0.75	0.75	0.75	NR	
	Steep Sloped (5 lb/ft <sup>2</sup> or more)	Aged Solar Reflectance	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	
		Thermal Emittance	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	
Fenestration	Maximum U-factor <sup>2</sup>		0.50 <sup>8</sup>	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.45 <sup>9</sup>	
	Maximum Solar Heat Gain Coefficient (SHGC) <sup>3</sup>		NR	0.40	0.40	0.25	0.40	0.40	0.25	0.40	0.40	0.40	0.25	0.25	0.30	0.25	0.25	NR	
	Maximum Total Area		20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	
	Maximum West Facing Area		NR	5%	NR	5%	NR	NR	5%	5%	5%	5%	5%	5%	5%	5%	5%	NR	
THERMAL MASS <sup>4</sup>			NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
SPACE-HEATING <sup>5, 10</sup>	Electric-resistant allowed		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	
	If gas, AFUE =		MIN <sup>8</sup>	MIN	MIN <sup>9</sup>														
	If heat pump, HSPF <sup>6</sup> =		MIN <sup>8</sup>	MIN	MIN <sup>9</sup>														
SPACE-COOLING	SEER =		MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	
	If split system, Refrigerant charge measurement or charge indicator display		NR	REQ	NR	NR	NR	NR	NR	REQ	NR								
Central Forced Air Handlers	Cooling Airflow and Watt Draw		NR	NR	NR	NR	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	NR	
	Central Fan Integrated Ventilation System Watt Draw		REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	
DUCTS	Duct sealing		REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	
	Duct Insulation		R-8	R-6	R-8	R-6	R-6	R-4.2	R-4.2	R-4.2	R-6	R-6	R-8	R-8	R-8	R-8	R-8	R-8	
WATER-HEATING			System shall meet §151(f)8 or §151(b)1																

**Footnote requirements to TABLE 151-B, TABLE 151-C and TABLE 151-D.**

- 1 The R-values shown for ceiling, wood frame wall and raised floor are for wood-frame construction with insulation installed between the framing members. For alternative construction assemblies, see §151(f)1A.  

The heavy mass wall R-value in parentheses is the minimum R-value for the entire wall assembly if the wall weight exceeds 40 pounds per square foot. The light mass wall R-value in brackets is the minimum R-value for the entire assembly if the heat capacity of the wall meets or exceeds the result of multiplying the bracketed minimum R-value by 0.65. Any insulation installed on heavy or light mass walls must be integral with, or installed on the outside of, the exterior mass. The inside surface of the thermal mass, including plaster or gypsum board in direct contact with the masonry wall, shall be exposed to the room air. The exterior wall used to meet the R-value in parentheses cannot also be used to meet the thermal mass requirement.
- 2 The installed fenestration products shall meet the requirements of §151(f)3.
- 3 The installed fenestration products shall meet the requirements of §151(f)4.
- 4 If the package requires thermal mass, the thermal mass shall meet the requirements of §151(f)5.
- 5 Thermostats shall be installed in conjunction with all space-heating systems in accordance with §151(f)9.
- 6 HSPF means "heating seasonal performance factor."
- 7 Electric-resistance water heating may be installed as the main water heating source in Package C only if the water heater is located within the building envelope and a minimum of 25 percent of the energy for water heating is provided by a passive or active solar system.
- 8 As an alternative under Package E in climate zone 1, glazing with a maximum 0.57 U-factor and a 92 percent AFUE furnace or an 8.4 HSPF heat pump may be substituted for the Package E glazing U-factor requirement. All other requirements of Package E must be met.
- 9 As an alternative under Package E in climate zone 16, glazing with a maximum 0.57 U-factor and a 90 percent AFUE furnace or an 8.4 HSPF heat pump may be substituted for may be substituted for the Package E glazing U-factor requirement. All other requirements of Package E must be met.
- 10 A supplemental heating unit may be installed in a space served directly or indirectly by a primary heating system, provided that the unit thermal capacity does not exceed two kilowatts or 7,000 Btu/hr and is controlled by a time-limiting device not exceeding 60 minutes.

---

**§152 (a) and §152 (b)**

(a) **Additions.** Additions to existing residential buildings shall meet the requirements of §111 through §118, §119, and §150, and either §152(a)1 or 2.

1. **Prescriptive approach.** Additions to existing buildings shall meet the following additional requirements:

- A. Fenestration in additions up to 100 ft<sup>2</sup> shall not have more than 50 ft<sup>2</sup> of fenestration area, and shall meet the U-factor and Solar Heat Gain Coefficient requirements of Package D ( §151(f)3A, §151(f)4 and Standards TABLE 151-C) or
- B. Additions up to 1000 ft<sup>2</sup> shall meet all the requirements of Package D (§151(f) and Standards TABLE 151-C), except that the addition's total glazing area limit is the maximum allowed in Package D plus the glazing area that was removed as a result of the construction of the addition, and the wall insulation value need not exceed R-13.

**EXCEPTION TO §152(a)1B:** In climate zones 2, 4, 7-15 the total allowed west-facing glazing area shall be five percent of the conditioned floor area of the addition plus the amount of west-facing glazing removed from the existing building as a result of the construction of the addition.

- C. Additions of more than 1000 ft<sup>2</sup> shall meet all the requirements of Package D (§151(f) and Package D (§151(f) and Standards TABLE 151-C).

2. **Performance approach.** Performance calculations shall meet the requirements of §151(a) through (e), pursuant to either Item A or B, below.

- A. For additions alone, the addition complies if the addition alone meets the combined water-heating and space-conditioning energy budgets as specified in §151(b).
- B. For existing plus addition plus alteration compliance. The energy use of the combination of the altered existing building plus the proposed addition shall be equal to or less than the energy use of the existing building with all alterations meeting the requirements of §152(b)2, plus the standard energy budget of an addition that complies with §151(a) through (e). When determining the standard design, the fenestration area shall be the smaller of the sum of the installed fenestration area up to 20 percent of the conditioned floor area of the addition plus glass removed from the existing building as a result of the construction of the addition or the proposed glass area in the addition.

**EXCEPTION 1 to §152(a):** Existing structures with R-11 framed walls showing compliance with §152(a)2 (Performance Approach) are exempt from §150(c).

**EXCEPTION 2 to §152(a):** If the addition will increase the total number of water heaters in the building, one of the following types of water heaters may be installed to comply with §152(a)1 or §152(a)2A:

- 1. A gas storage non-recirculating water heating system that does not exceed 50 gallons capacity; or
- 2. If no natural gas is connected to the building, an electric storage water heater that does not exceed 50 gallons capacity, has an energy factor not less than 0.90; or

3. A water heating system determined by the executive director to use no more energy than the one specified in Item 1 above; or if no natural gas is connected to the building, a water heating system determined by the executive director to use no more energy than the one specified in Item 2 above.

For prescriptive compliance with §152(a)1, the water heating systems requirement in §151(f)8 shall not apply. For performance compliance for the addition alone, only the space-conditioning budgets of §151(b)2 shall be used; the water-heating budgets of §151(b)1 shall not apply.

The performance approach for the existing building and the addition in §152(a)2B may be used to show compliance, regardless of the type of water heater installed.

**EXCEPTION 3 to §152(a):** When heating and/or cooling will be extended to an addition from the existing system(s), the existing heating and cooling equipment need not comply with Title 24, Part 6. The heating system capacity must be adequate to meet the minimum requirements of CBC Section 1204.

**EXCEPTION 4 to §152(a):** When ducts will be extended from an existing duct system to serve the addition, the ducts shall meet the requirements of §152(b)1D.

**EXCEPTION 5 to §152(a):** Additions 1,000 ft<sup>2</sup> or less are exempt from the requirements of §150(o). For additions larger than 1,000 ft<sup>2</sup>, application of §150(o) shall be based on the conditioned floor area of the entire dwelling unit, not just the addition.

(b) **Alterations.** Alterations to existing residential buildings or alterations in conjunction with a change in building occupancy to a low-rise residential occupancy shall meet either Item 1 or 2 below.

1. **Prescriptive approach.** The altered component and any newly installed equipment serving the alteration shall meet the applicable requirements of §110 through §118, §119, and §150(a) through §150(p); and
  - A. Alterations that add fenestration area shall meet the U-factor requirements of Package D (§151(f)3A and Standards Table 151-C), the total fenestration area and west-facing fenestration area requirements of Package D (§151(f)3B and C and Table 151-C), and the Solar Heat Gain coefficient requirements of Package D (§151(f)4 and Standards Table 151-C).

**EXCEPTION to §152(b)1A:** Alterations that add fenestration area of up to 50 ft<sup>2</sup> shall not be required to meet the total fenestration area and west-facing fenestration area requirements of §151(f)3B and C. The existing west-facing fenestration area shall not be increased by more than 50 ft<sup>2</sup>.

- B Replacement fenestration, where existing glazing is replaced with a new manufactured fenestration product in the same orientation and tilt, shall meet the U-factor and Solar Heat Gain Coefficient requirements of Package D (§151(f)3A and §151(f)4 and Standards Table 151-C).

**NOTE:** Glass replaced in an existing sash and frame, or replacement of a single sash in a multi-sash fenestration product are considered repairs.

- C. New or replacement space-conditioning systems shall:
  - i. Meet the requirements of §150(h), §150(i), §150(j)2, §151(f)6, §151(f)7, and §151(f)9; and

- ii. Be limited to natural gas, liquefied petroleum gas, or the existing fuel type unless it can be demonstrated that the TDV energy use of the new system is more efficient than the existing system.
- D. When more than 40 ft of new or replacement space-conditioning ducts are installed in unconditioned space, the new ducts shall meet the requirements of §150(m) and the duct insulation requirements of Package D §151(f)10. If ducts are installed in climate zones 2, 9, 10, 11, 12, 13, 14, 15, or 16, the duct system shall be sealed, as confirmed through field verification and diagnostic testing in accordance with procedures for duct sealing of existing duct systems as specified in the Reference Residential Appendix RA3, to meet one of the following requirements:
- i. If the new ducts form an entirely new duct system directly connected to the air handler, the measured duct leakage shall be less than 6 percent of fan flow and meet the airflow requirements of Reference Residential Appendix RA3; or
  - ii. If the new ducts are an extension of an existing duct system, the combined new and existing duct system shall meet one of the following requirements:
    - a. The measured duct leakage shall be less than 15 percent of system fan flow; or
    - b. The measured duct leakage to outside shall be less than 10 percent of system fan flow; or
    - c. The duct leakage shall be reduced by more than 60 percent relative to the leakage prior to the installation of the new ducts and a visual inspection including a smoke test shall demonstrate that all accessible leaks have been sealed; or
    - d. If it is not possible to meet the duct sealing requirements of Subsection a, b, or c, all accessible leaks shall be sealed and verified through a visual inspection and a smoke test by a certified HERS rater.

**EXCEPTION to §152(b)1Dii:** Existing duct systems that are extended, which are constructed, insulated or sealed with asbestos.

- E. In climate zones 2, 9, 10, 11, 12, 13, 14, 15, and 16, when a space-conditioning system is altered by the installation or replacement of space-conditioning equipment (including replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, cooling or heating coil, or the furnace heat exchanger) the duct system that is connected to the new or replacement space-conditioning equipment shall be sealed, as confirmed through field verification and diagnostic testing in accordance with procedures for duct sealing of existing duct systems as specified in the Reference Residential Appendix RA3, to one of the following requirements.
- i. The measured duct leakage shall be less than 15 percent of system fan flow; or
  - ii. The measured duct leakage to outside shall be less than 10 percent of system fan flow; or
  - iii. The measured duct leakage shall be reduced by more than 60 percent relative to the measured leakage prior to the installation or replacement of the space conditioning equipment and a visual inspection, including a smoke test, shall demonstrate that all accessible leaks have been sealed; or

- iv. If it is not possible to meet the duct requirements of i, ii, or iii, all accessible leaks shall be sealed and verified through a visual inspection and a smoke test by a certified HERS rater.

**EXCEPTION 1 to §152(b)1E:** Duct systems that are documented to have been previously sealed as confirmed through field verification and diagnostic testing in accordance with procedures in the Reference Residential Appendix RA3.

**EXCEPTION 2 to §152(b)1E:** Duct systems with less than 40 linear feet in unconditioned spaces.

**EXCEPTION 3 to §152(b)1E:** Existing duct systems constructed, insulated or sealed with asbestos.

- F. When a space-conditioning system is altered by the installation or replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, cooling or heating coil, or the furnace heat exchanger, the following requirements shall be met:
  - i. Non-setback thermostats shall be replaced with setback thermostats meeting the requirements of §112(c); and
  - ii. Meet the refrigerant charge and airflow requirements of Reference Residential Appendix RA3.

**EXCEPTION to §152(b)1Fii:** Heating only systems need not comply with this requirement.

- G. New service water-heating systems or components shall:
  - i. Meet the requirements of §150; and
  - ii. Be limited to natural gas, liquefied petroleum gas, or the existing fuel type unless it can be demonstrated that the TDV energy use of the new system is more efficient than the existing system.
- H. Replacements of the exterior surface of existing roofs shall meet the requirements of §118 and the applicable requirements of Subsections i through iii where more than 50 percent of the roof or more than 1,000 ft<sup>2</sup> roof, whichever is less, is being replaced:
  - i. For Steep-sloped roofs, roofing products with a density of less than five pounds per square foot in climate zones 10 through 15 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.
  - ii. For steep-sloped roofs, roofing products with a density of five pounds per square foot or more in climate zones 1 through 16 shall have a minimum aged solar reflectance of 0.15 and a minimum thermal emittance of 0.75, or a minimum SRI of 10.

**ALTERNATIVE TO §152(b)1Hi and ii:** The following shall be considered equivalent to Subsection i and ii:

- a. Insulation with a thermal resistance of at least 0.85 hr·ft<sup>2</sup>·°F/Btu or at least a 3/4 inch air-space is added to the roof deck over an attic or
- b. Existing ducts in the attic are insulated and sealed according to §151(f)10; or
- c. In climate zones 10, 12 and 13, with 1 ft<sup>2</sup> of free ventilation area of attic ventilation for every 150 ft<sup>2</sup> of attic floor area, and where at

- least 30 percent of the free ventilation area is within 2 ft vertical distance of the roof ridge; or
- d. Buildings with at least R-30 ceiling insulation; or
  - e. Buildings with a radiant barrier in the attic meeting the requirements of §151(f)2; or
  - f. Buildings that have no ducts in the attic; or
  - g. In climate zones 10, 11, 13 and 14, R-3 or greater roof deck insulation above vented attic.
- iii. Low-sloped roofs in climate zones 13 and 15 shall have a 3-year aged solar reflectance equal or greater than 0.55 and a thermal emittance equal or greater than 0.75, or a minimum SRI of 64.

**EXCEPTION to §152(b)1Hiii:** Buildings with no ducts in the attic.

## 2. Performance approach.

- A. The altered components shall meet the applicable requirements of §110 through §118, §119, and §150(a) through (p); and
- B. When the altered components do not meet the requirements specified in the Sections that are stated in subsections i through viii, the standard energy budget (energy budget) shall be based on the requirements stated in those Sections as follows:
  - i. Ceiling Insulation. The energy budget shall be based on the requirements of §118(d).
  - ii. Wall Insulation. The energy budget shall be based on the requirements of §150(c).
  - iii. Raised-floor Insulation. The energy budget shall be based on the requirements of §150(d).
  - iv. Fenestration. The energy budget shall be based on the U-factor and SHGC value requirements of Standards Table 151-C. The allowed glass area shall be the glass area of the existing building.
  - v. Space-Heating and Space-Cooling Equipment. The energy budget shall be based on the requirements of Standards Table 151-C.
  - vi. Ducts. The energy budget shall be based on the requirements of §152(b)1D.
  - vii. Water Heating Systems. The energy budget shall be based on requirements of §151(b)1.
  - viii. Roofing Products. The energy budget shall be based on §152(b)1H.
- C. When the altered components meet the requirements specified in §152(b)2B, subsections i through viii, the standard energy budget shall be based on existing conditions.

### NOTES TO §152(b)2:

- A. If an existing component must be replaced with a new component, that component is considered an altered component for the purpose of determining the energy budget and must meet the requirements of §152(b)2B.
- B. The proposed design shall be based on the actual values of the altered components.

C. The standard design shall assume the same geometry and orientation as the proposed design.

**EXCEPTION to §152(b):** Any dual-glazed greenhouse window installed as part of an alteration complies with the U-factor requirements in §151(f)3.

**Residential Table – Vintage Table Values****TABLE R3-50 – DEFAULT ASSUMPTIONS FOR EXISTING BUILDINGS – VINTAGE TABLE VALUES****Default Assumptions for Year Built (Vintage)**

Conservation Measure	Before 1978	1978 to 1983	1984 to 1991	1992 to 1998	1999 - 2000	2001- 2003	2004- 2005	2006 and Later
<b>INSULATION U-FACTOR</b>								
Roof/Ceiling	0.079	0.049	0.049	0.049	0.049	0.049	0.049	0.049
Wall	0.356	0.110	0.110	0.102	0.102	0.102	0.102	0.102
Raised Floor –Crawl Space	0.099	0.099	0.099	0.046	0.046	0.046	0.046	0.046
Cool Roof	0.10	0.10	0.10	0.10	0.10	0.10	0.10	Pres Pkg.
Radiant Barrier	None	None	None	None	None	None	Pres Pkg.	Pres Pkg.
Raised Floor-No CrawlSp	0.238	0.238	0.238	0.064	0.064	0.064	0.064	0.064
Slab Edge F-factor =	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73
Ducts	R-2.1	R-2.1	R-2.1	R-4.2	R-4.2	R-4.2	R-4.2	Pres Pkg.
<b>LEAKAGE</b>								
Building (SLA)	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
Duct Leakage Factor (See Table 4-13)	0.86	0.86	0.86	0.86	0.86	0.89	0.89	0.89
<b>FENESTRATION</b>								
U-factor	Use Standards Table 116-A , §116 for all Vintages							
SHGC	Use Standards Table 116-B , §116 for all Vintages							
Shading Dev.	Use Table R3-27 and R3-28 for all Vintages in the Residential ACM Manual – Performance Approach							
<b>SPACE HEATING EFFICIENCY</b>								
Gas Furnace (Central) AFUE	0.75	0.78	0.78	0.78	0.78	0.78	0.78	0.78
Gas Heater (Room) AFUE	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Hydronic/Comb Hydronic	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
Heat Pump HSPF	5.6	5.6	6.6	6.6	6.8	6.8	6.8	7.4
Electric Resistance HSPF	3.413	3.413	3.413	3.413	3.413	3.413	3.413	3.413
Electric Resistance Radiant HSPF	3.55	3.55	3.55	3.55	3.55	3.55	3.55	3.55
<b>SPACE COOLING EFFICIENCY</b>								
All Types, SEER	8.0	8.0	8.9	9.7	9.7	9.7	9.7	13.0
<b>WATER HEATING</b>								
Energy Factor	0.525	0.525	0.525	0.525	0.575	0.575	0.575	0.575

**Appliance Efficiency Standards**

**Table F-3  
Standards for Large Water Heaters**

<b>Appliance</b>	<b>Input to Volume Ratio</b>	<b>Size (Volume)</b>	<b>Minimum Thermal Efficiency (%)</b>	<b>Maximum Standby Loss<sup>1,2</sup></b>
Gas storage water heaters	< 4,000 Btu/hr/gal	any	80	$Q/800 + 110(V_r)1/2$ Btu/hr
Gas instantaneous water heaters	$\geq 4,000$ Btu/hr/gal	< 10 gal	80	–
		$\geq 10$ gal	80	$Q/800 + 110(V_r)1/2$ Btu/hr
Gas hot water supply boilers	$\geq 4,000$ Btu/hr/gal	< 10 gal	80	–
		$\geq 10$ gal	80	$Q/800 + 110(V_r)1/2$ Btu/hr
Oil storage water heaters	< 4,000 Btu/hr/gal	any	78	$Q/800 + 110(V_r)1/2$ Btu/hr
Oil instantaneous water heaters	$\geq 4,000$ Btu/hr/gal	< 10 gal	80	–
		$\geq 10$ gal	78	$Q/800 + 110(V_r)1/2$ Btu/hr
Oil hot water supply boilers	$\geq 4,000$ Btu/hr/gal	< 10 gal	80	–
		$\geq 10$ gal	78	$Q/800 + 110(V_r)1/2$ Btu/hr
Electric storage water heaters	< 4,000 Btu/hr/gal	any	–	$0.3 + 27/V_m$ %/hr

<sup>1</sup> Standby loss is based on a 70° F temperature difference between stored water and ambient requirements. In the standby loss equations,  $V_r$  is the rated volume in gallons,  $V_m$  is the measured volume in gallons, and Q is the nameplate input rate in Btu/hr.

<sup>2</sup> Water heaters and hot water supply boilers having more than 140 gallons of storage capacity are not required to meet the standby loss requirement if the tank surface is thermally insulated to R-12.5, if a standing pilot light is not installed, and for gas- or oil-fired storage water heaters, there is a flue damper or fan-assisted combustion.

**Table F-4**  
**Standards for Small Federally-Regulated Water Heaters**

<b>Appliance</b>	<b>Minimum Energy Factor</b>	
	<b>Effective April 15, 1991</b>	<b>Effective January 20, 2004</b>
Gas-fired storage-type water heaters	$0.62 - (.0019 \times V)$	$0.67 - (.0019 \times V)$
Oil-fired water heaters (storage and instantaneous)	$0.59 - (.0019 \times V)$	$0.59 - (.0019 \times V)$
Electric storage water heaters (excluding tabletop water heaters)	$0.93 - (.00132 \times V)$	$0.97 - (.00132 \times V)$
Electric tabletop water heaters	$0.93 - (.00132 \times V)$	$0.93 - (.00132 \times V)$
Gas-fired instantaneous water heaters	$0.62 - (.0019 \times V)$	$0.62 - (.0019 \times V)$
Electric instantaneous water heaters (excluding tabletop water heaters)	$0.93 - (.00132 \times V)$	$0.93 - (.00132 \times V)$
Heat pump water heaters	$0.93 - (.00132 \times V)$	$0.97 - (.00132 \times V)$
<i>V = rated volume in gallons.</i>		